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ABSTRACT

Undergraduate students using an imagery mnemonic mediating technique involving "keywords" to learn definitions of thirty unfamiliar words performed better on a 1-week delayed comprehension test, on at least half of the definitions, than those who read and copied definitions. Mnemonic mediating strategies worked better than nonmediating strategies on both immediate and delayed occasions. The superiority of the mediating strategies was greater on the concrete than the abstract definitions. There were moderately large positive correlations between the degree to which participants in the mediating groups used the prescribed processing methods and comprehension test scores. (Author/GDC)

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EFFECTS OF IMAGERY, MNEMONICS AND LEVEL OF PROCESSING IN LEARNING DEFINITIONS UPON CONCEPT COMPREHENSION

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ABSTRACT

Students using an imagery mnemonic mediating technique involving "keywords" in a definitional learning task on at least half of the definitions performed better on a 1-week delayed comprehension test (one-half of a standard deviation, $p < .05$), than those who read and copied definitions. Mnemonic mediating strategies worked better ($p < .01$) than nonmediating strategies on both immediate and delayed occasions. The superiority of the mediating strategies was greater on the concrete than the abstract definitions ($p < .05$). There were significant and moderately large positive correlations between the degree to which participants in the mediating groups used the prescribed processing methods and comprehension test scores.

Empirical research has generated an abundance of generalizations about concept learning. Investigators have noted, however, that there are major differences between the concept learning usually studied in the laboratory and concept learning in the classroom (Carroll, 1964; Remstad, 1969; Martorella, 1971). In particular, few studies have investigated ways of facilitating learning concepts from definitions (e.g., Anderson & Kulhavy, 1972; Bull & Wittrock, 1973). Learning concepts in an inductive way from concrete experience as in most research is a way of producing comprehension for concrete concepts. However, the primary mode of learning concepts in schools is the more verbal mode of learning concepts from definitions. Gagne (1977) has differentiated between these two different types of concept learning. The first type is referred to as learning concrete concepts and the second as learning defined concepts. According to Gagne some abstract concepts like "city" and "justice" have to be learned as defined concepts.

"Atavistic" is one of these concepts. "Atavistic" means a kind of reversion to a primitive type or recurrence of primitive characteristics, like a throwback. The meaning is difficult to remember and to associate with the word because the word is abstract and in addition seems to have no relationship to its meaning. Many situations require individuals to learn large numbers of unfamiliar words like "atavistic" from definitions in short periods of time. Courses like geometry, chemistry, physiology, zoology, computer science, etc., require learning long lists of unfamiliar technical terms. Whenever one enters a new technical field, one is confronted with a host of technical jargon. Such vocabulary building generally requires learning from definitions. When it is further considered that looking up words in a dictionary is a primary means of achieving vocabulary growth it becomes apparent that the learning of defined

concepts, or definitional learning, should receive more study. Research is needed to improve efficiency of such learning.

This study investigates how to transform the information contained in the definition of a concept into a form that renders it more memorable. Specific purposes are: (a) to develop cognitive strategies for facilitating definitional learning; and (b) to test the viability of theoretical precepts derived in more basic contexts when they are applied to the more complex context of definitional learning. The strategies were to be acquired within five minutes, effective for general vocabulary acquisition, usable whenever unfamiliar words were encountered and the defining terms were understood and adaptable for use in texts or instructional sequences.

Three theoretical frameworks supply the basis for predictions. Craik and Lockhart's (1972) levels of processing orientation suggests that processing definitions at a deeper level should facilitate retention of the information contained in the definition. The research of Atkinson (1975), Bower (1970), Rohwer (1970), and Paivio (1971) suggests that effective mediators can be constructed to link unfamiliar concept labels with their defining attributes in memory and thus facilitate retention of information. Third, Paivio's (1971) dual processing approach suggests that images, mental pictures, formed by participants should facilitate retention of information more with concrete definitions than with abstract definitions.

Method

Participants

A total of 120 undergraduate educational psychology students at the University of Nebraska at Lincoln participated in the experiment as a course

option. Twenty-four participants were randomly assigned to each of five independent treatment groups.

Materials

Concepts and definitions. From the Johnson (1978) norms developed for a subset of the Lorge-Thorndike (1944) list of words used with frequencies of 4 per 18,000,000, fifteen abstract (below the mean of the ratings on concreteness) and fifteen concrete (above the mean of the ratings on concreteness) concepts and their definitions were selected, such that they constituted matched pairs with respect to the comprehensibility and the complexity ratings of the definitions (see Table 1). These concepts and their definitions were used as the experimental items for the concrete versus abstract levels of the concreteness factor. They were included in five sets of booklets, one per page, in random order along with sufficient space for the participants to respond to the concepts and definitions in terms of the instructional set each was presented. In addition, on each page a five point rating scale was provided along with directions for participants to rate their prior knowledge of the word.

Mediating keywords. A set of criteria was written for the composition of keywords for the unfamiliar words. These criteria were the following: That the keywords be (a) acoustically or phonologically related to the concept label, (b) concrete, (c) relatively high frequency nouns, (d) relatively easy to understand, and (e) semantically unrelated to the unfamiliar words.

A committee of three judges individually brainstormed keywords for each unfamiliar word. The three judges then individually chose the 3 proposed keywords which best fit the above criteria and ranked them. The word ranking highest for each unfamiliar word was chosen as a keyword. These keywords served as conceptual pegs for the mnemonic mediating strategy groups.

Instructional sets.* Five different sets of instructional sequences were designed to be administered to the five independent groups of participants for processing the definitions. "Read and copy" instructions operationalized Craik and Lockhart's less thorough level of processing. "Paraphrase" instructions operationalized a deeper level of processing involving primarily verbal processes. Instructions to form mental pictures operationalized a deeper processing level, involving primarily imagery processes. Two other sets of instructions instruct participants to use keyword associative mediators to link the unfamiliar word to its definition. Take the definition of "atavistic," for example. A keyword mediator having a known meaning like the word "native" and sounding like a part of the word "atavistic" is presented with the definition and later recalled upon seeing "atavistic," prompting memory for the meaning of the word. The mediating word is used to link the definition to the concept label in memory, using either a mental picture or a more verbal association. The first set of instructions directs participants to construct mental pictures representing the mediating word and the definition interacting in some way. The second instructs participants to construct a plausible relationship between the two. Experimental control over processing behaviors was reinforced by requiring participants to respond in writing to instructions for each new concept presented.

Reliability of Adherence to method scores. To assess the reliability of the participants' adherence to the prescribed processing methods, a stratified random sample of 20 of the original 120 learning tasks was selected by randomly choosing four completed learning tasks from each of the five groups. For each response of each of the 20 participants, two independent judges classified which method participants used. After each response was classified, responses were

then dichotomously reclassified into those adhering to the prescribed learning method and those not so doing. This reclassification was carried out for both judges. A response was coded a "0" of the participant failed to use the correct method and coded a "1" if the participant did use the correct method. These codes were then summed for each of the 120 participants and for both judges' classifications of the random subsample of 20. Sums based on the classifications of the first or primary judge provided a measure of the extent to which participants actually used the learning method appropriate for their group throughout the entire learning task. The two judges' sums for each participant of the sample of 20 were correlated to provide an index of the reliability of the adherence to method scores thus obtained.

Comprehension test. Two multiple-choice items were written for each concept by a method similar to that prescribed by Anderson (1972). Both items for each concept were included within each comprehension test. Reliabilities of the abstract and concrete subscales and overall comprehension test were assessed by coefficient alpha. On the immediate comprehension test the reliabilities of the abstract and concrete subscales were .92 and .93 respectively. Each subscale consisted of 30 multiple-choice items. The overall reliability of the immediate test was .95. On the one-week delayed comprehension test the reliabilities of the abstract and concrete subscales were again .92 and .93, respectively. Each subscale again consisted of 30 multiple-choice items. The overall reliability of the delayed comprehension test was .96. Validity was assured by selecting positive instances of the concepts as correct alternatives on the multiple-choice test, while incorrect alternatives consisted of random triples of the correct alternatives for the other concept definitions presented during the study task.

Design

The design (see Table 2) was a 2 x 2 x 2 x 2 x 2 partially crossed (level of processing x concreteness x processing mode x associative mediation (present vs. absent) x occasion (immediate vs. delayed)), with two within subjects factors, those being concreteness and occasion and three between subjects factors. Processing mode and associative mediation were not crossed with level of processing, but occurred only within the level 2 or deeper processing level. The dependent variables were the scores on the immediate and delayed tests, which assessed comprehension by identification of new instances of the concepts in a multiple-choice format.

Procedure

Participants were run in groups of 25 to 50. All treatments were run concurrently with treatments assigned by random distribution of materials within the groups. Concept labels and definitions, both abstract and concrete, accompanied by instructions to rate prior knowledge were randomly presented one at a time in booklets, one item per page, participants being cued by the experimenter once each 90 seconds to proceed to the next item. Prior knowledge ratings were made on a scale of from 1 to 5 with "1" representing that the participant was certain the definition was not previously known and "5" representing that the participant was certain the definition was previously known. All participants were allotted identical study times for each concept and definition. Each participant then responded to both test items for each concept studied on each occasion. Order of the items was scrambled on the second test. All participants had the same length of time to respond on each test. On the second occasion participants returned a week after the first session and responded to the second form of the comprehension test.

Results

Each participant's performance was assessed on each of 12 variables:

(a) Abstract Prior Knowledge (the sum of prior knowledge ratings of the words having low concreteness);
(b) Concrete Prior Knowledge (the sum of the prior knowledge ratings of the words having high concreteness);
(c) Total Prior Knowledge (the sum of all prior knowledge ratings);
(d) Adherence to Method on Abstract Definitions (extent to which participants use prescribed learning method on abstract definitions);
(e) Adherence to Method on Concrete Definitions (extent to which participants use prescribed learning method on concrete definitions);
(f) Total Adherence to Method (extent to which participants use prescribed learning method over both abstract and concrete definitions);
(g) Immediate Abstract Comprehension (score on subscale of immediate comprehension test consisting of abstract items);
(h) Immediate Concrete Comprehension (score on subscale of immediate comprehension test consisting of concrete items);
(i) Immediate Total Comprehension (total score on immediate comprehension test);
(j) Delayed Abstract Comprehension (score on subscale of delayed comprehension test consisting of abstract items)
(k) Delayed Concrete Comprehension (score on subscale of delayed comprehension test consisting of concrete items) and
(l) Delayed total comprehension (total score on delayed comprehension test).

Means and standard deviations on the 12 variables for each of the treatment groups are presented in Table 3. The abstract and concrete subscale means for the five treatment groups are circled. They indicate the presence of a ceiling effect on the 30 item subscales.

The mixed-model repeated measures analysis of variance (Finn, 1972) was conducted on the independent variables of level of processing, mode of processing, and mediation condition and the dependent variables of abstract and concrete

comprehension repeated over the immediate and delayed occasions. The keyword mediated groups performed significantly superiorly to the nonmediated groups within the deeper level of processing ($F = 7.501$; $df = 1$; $p < .007$) (see Table 4). The interaction of keyword mnemonic mediation by concreteness within the deeper processing level was significant at the .05 level ($F = 6.729$; $df = 1,115$; $p < .011$), as was the main effect of occasions ($F = 5.655$; $df = 1,115$; $p < .019$) across all groups. Graphs of these results are presented in figure 1.

Prior to making meaningful comparisons between treatments, it was necessary to determine whether there was a significant difference in participants' prior knowledge of the 15 abstract versus 15 concrete definitions. The overall mean Prior Knowledge ratings for the abstract versus the concrete definitions were 24.10 (SD = 6.64) and 23.87 (SD = 6.70), respectively. It is apparent that this difference is trivial. Only six items of the 30 had Prior Knowledge mean ratings of 2 or above. A "2" represented that the participant "thought" the definition was previously unknown. The definitions of "curricle" and "jodhpurs" were best known by the 120 experimental participants with mean Prior Knowledge ratings of 2.57 and 2.99 respectively. The least well known item was "exegesis" and its definition, with a mean Prior Knowledge rating of 1.05.

Concerning the adherence to method scores the inter-rater reliability was .93 for the random subsample of 20 participants from the five groups. Correlations between the adherence to method scores and comprehension test scores revealed moderate relationships in the keyword mediating groups. In the Verbal Keyword group adherence to method on concrete definitions correlated .46 and .44 with comprehension test scores on the first and second occasions, respectively, while they correlated .64 and .64 in the Imagery Keyword group. These correlations were significant ($p < .05$, $df = 22$). Thus, it appeared that as

participants in these groups used the correct method more, they tended to score higher on the comprehension tests. Since, the correlations indicated that if participants failed to use the correct method they might do poorly, and since participants had only had five minutes to acquire these rather strange new methods, it was decided to conduct a second analysis of the data including in the sample only participants who used the method they were instructed to use at least half the time.

The Imagery Keyword mnemonic group had the most participants (5) who failed to use the correct method at least half the time. These participants were deleted, leaving 19. In other groups first the participants failing to meet the criterion were deleted then other participants were randomly deleted from each group until 19 remained. Two planned comparisons were also made between the comprehension totals of the Imagery Keyword Mnemonic group and the Read and Copy group to determine whether the interactive imagery technique would produce superior total comprehension performance on the immediate and delayed occasions when the usage criterion was adhered to. Means and standard deviations on immediate and delayed, abstract and concrete comprehension for each of the reduced treatment groups are presented in Table 5.

The mixed-model repeated measures analysis of variance was conducted in a manner identical to the first analysis, except that now the group size was 19. There was, again, a significant two-way ordinal interaction between mediational condition and the concreteness of the definitions within the second level of processing ($F = 7.313$; $df = 1,90$; $p < .008$) (see Table 6). The main effect of keyword mnemonic mediation within processing level II was again significant ($F = 12.978$; $df = 1,90$; $p < .001$), as was the main effect of occasions ($F = 7.424$; $df = 1,90$; $p < .008$). Furthermore, the planned comparison between the Read and

Copy and the Imagery Keyword delayed comprehension totals was also significant at the .05 level (M(RC) = 48.579 vs. M(IK) = 54.895, SD(RC) = 9.600, SD(IK) = 7.802; $t = 2.225$, $p < .05$). On the immediate occasion the difference was marginally significant, (M(RC) = 51.842 vs. M(IK) = 55.947; SD(RC) = 7.120, SD(IK) = 5.816; $t = 1.946$, $p < .10$). The estimate of the effect size obtained from the difference in the delayed comprehension test totals of the Read and Copy and the Imagery Keyword Mnemonic groups was approximately half a standard deviation, with the raw score difference between the means of the two groups being 6.32 (SD = 12.37). Graphs of the results of the second analysis are presented in Figure 2.

Discussion

Students using the imagery mnemonic mediating technique on at least half of the definitions performed significantly superiorly (one-half a standard deviation, $p < .05$) to those who read and copied definitions and all other groups as well on the one-week delayed comprehension test. The mnemonic mediating techniques, as predicted, were significantly superior to the non-mediated techniques at the deeper or more elaborative processing level in both analyses. Thus, the use of the keywords in constructing either imaginal or verbal relationships with the definitions was a more effective method for learning the definitions than simply paraphrasing the definitions or forming images representing them. Furthermore, the superiority of the mediating strategies was greater on the concrete than on the abstract definitions for both the immediate and delayed occasions.

When considering all hypothesis tests, analysis of data from participants who used the correct methods at least half the time reinforces or strengthens

the results of the analysis of data from all experimental participants (see Tables 5 and 6). Examination of tables 5 and 6 reveals that the primary difference in these two analyses is that the two effects which were significant at the .05 level in the analysis of all participants were significant at the .01 level in the analysis of the 95 participants meeting the usage criterion. In addition, there were significant and moderately large positive correlations between the degree to which participants in the mediating groups used the prescribed processing methods and comprehension test scores.

These results are especially notable in view of the following facts: (a) participants acquired the techniques in five minutes via very short instructional sequences; (b) a ceiling effect may have tended to obscure potentially larger differences; (c) some participants indicated in post-treatment feedback that they had been able to use a process of elimination to arrive at correct alternatives in the comprehension test; and (d) at least two and probably all three, including imagery, of the non-mnemonic techniques were ones with which participants were likely to have had considerable previous acquaintance and practice. Thus, participants using the mnemonic techniques were likely to have been operating at a disadvantage by having had an unfamiliar new learning style substituted for customary methods of processing the definitional materials. The presence of only a small, but significant, occasion effect seems to indicate that the participants either (a) learned from the first test and were able to identify some correct alternatives on the second occasion because they remembered them as correct responses from the first occasion; or (b) may have reviewed the definitions during the interim. Both of these seem likely given participant comments and in further research should be attended to.

It appears that the concreteness by mnemonic mediation interaction is best explained in terms of the dual-processing position (Paivio, 1971). The interaction between concreteness and mediation may have occurred because: (a) It was easier to encode either a verbal or an image relationship between the keyword and the definition when the definition was concrete than when it was abstract; (b) the keyword methods may have been used more on the concrete definitions than they were on the abstract definitions (actually, if it were easier to encode relationships between keywords and concrete definitions, it would be expected that keyword methods might be used more on the concrete); (c) there may have been fewer problems during retrieval in decoding relationships formed with concrete definitions than there were with abstract definitions; (d) there may have been differences in trace survival or retention rates; and (e) finally, there may have been some combination of the above factors and/or other unknown factors.

A dual processing orientation (Paivio, 1971) would suggest availability of both verbal and image codes for linking concrete definitions with the keywords, while abstract definitions have primarily verbal codes. Thus, the number of linking codes being greater for concrete than abstract definitions, encoding and decoding might be expected to be facilitated by keyword mnemonics more with concrete than with abstract definitions. For example, take the definition of the concrete concept "carnelian" which refers to a red quartz-like mineral and which was assigned the keyword "carnation." To form an interactive image between a carnation and a red quartz-like mineral is relatively straightforward. One can "see" a carnation growing out of or wrapped around the red mineral, for example, or one can "see" a carnation carved out of a red quartz-like rock rather quickly. These are images which can be formed in a relatively straightforward manner. But, take the definition of "octroi," which refers to a tax on goods entering a city and has the keyword

"octopus." It is more difficult to conjure up interactive images relating these two terms. First, there is the problem of finding some sort of visual representation of a "tax on goods entering a city"; second, there is the problem of joining that with "octopus" in a mental picture; and third, there is the problem of decoding the representation of the "tax" during retrieval. The point is that the process of forming interactive images for concrete items is a less problem-fraught process. The likelihood of either encoding failure or decoding failure is less in the case of the straightforward, well-learned associations between the visual representations of concrete objects and their names.

There was some evidence, especially in the Imagery Keyword Mnemonic group, that the mnemonic method was used correctly more on the concrete than on the abstract definitions. The mean adherence to method score for the Imagery Keyword Mnemonic group was 9.96 (SD = 5.16) for the abstract definitions and 12.17 (SD = 4.22) for the concrete definitions, respectively. For the Verbal Keyword Mnemonic group, means were 10.79 (SD = 4.05) for the abstract and 11.79 (SD = 3.41) for the concrete. Thus, in the samples, particularly in the Imagery Keyword group, the mnemonic methods were used correctly more often on the concrete concepts than on the abstract concepts. These figures, together with the previously noted significant correlations of abstract and concrete comprehension performance with participants' adherence to method scores in these groups, support the hypothesis that the superior facilitation of comprehension for concrete definitions in comparison with abstract definitions may have resulted from greater frequency of correct usage of the keyword methods with concrete definitions, which, in turn, is consistent with the notion that linking codes are more accessible for concrete than for abstract concepts. The design of this experiment does not allow a more specific determination of

the locus of the interaction and thus could be attributed to either processes during encoding or decoding processes during retrieval or both. The result, however, although not predicted, appears to support the dual-processing position.

It had been expected that imagery processing would facilitate concrete comprehension more than abstract comprehension in comparison with verbal processing. However, the expected interaction between processing mode (verbal vs. visual) and the concreteness of the definitions did not occur. This seems to be a likely consequence of several considerations having to do with the way in which the relevant comparisons were operationalized: (a) Participants in the imagery groups were informed how to concretize the abstract definitions by forming mental pictures of concrete representations of the abstract terms (like visualizing a dumbbell to symbolize strength). (b) Imagery may be an important component of paraphrasing or forming a verbal relationship as instructed in the directions for the Verbal Keyword Mnemonic group (i.e., to paraphrase, an image might be constructed which is then renamed in the paraphrasing operation). (c) The comprehension test may not have been sensitive enough to register such differences (i.e., too small a proportion of the total variance in comprehension test scores might be accounted for by treatment conditions, the observed ceiling effect and the presence of the test-wiseness process of elimination tending to obscure any such effect). (d) According to a dual processing orientation, one might even expect abstract comprehension to be facilitated more than concrete comprehension by the imagery processing, if the coding and decoding problems peculiar to abstract materials could be solved. This could occur because the addition of the auxiliary imagery code to the basic verbal code would add a second code for retaining the information from abstract materials, whereas it would only amplify an already existing

code in the case of concrete materials. An important point is that if instructions to form mental pictures result in little or no additional imagery, little facilitation, or even a decrement, could be expected. Thus, it appears that these comparisons considered as a whole are consistent with the dual-processing position (Paivio, 1971) applied to the context of definitional learning.

The absence of a difference in comprehension performance between the two processing levels was the most surprising outcome of this study, and, at first appearance, seemed inexplicable. It was expected that the deeper or more elaborative levels of processing would have superior information retention characteristics in comparison with the less elaborative Read and Copy group. In fact, the Paraphrase and Imagery groups without keywords had the poorest performance of all on the comprehension test.

There were a number of possibilities, however, as to why the expected superiority of the more elaborative processing level groups did not materialize. The primary candidate was the consistent presence of the unfamiliar word followed immediately by the defining terms in the sentence copied by the Read and Copy group, as opposed to the consistent absence of this in the Paraphrase and Imagery groups' responses. In other words, rote verbal linking processes may not have been equal across Read and Copy, Paraphrase, and Imagery treatments. To equalize this in further research participants in the various groups could be (a) provided with stems which include the unfamiliar word (i.e., "Atavistic means..."), or (b) induced always to include the new word in every constructed sentence or phrase.

A second likely reason was the possibility that in instructing participants of the Paraphrase group to "repeat as few of the nouns, verbs and modifiers actually appearing in the definition as possible" that the nature of the

task for this group may have changed from that of putting the definition into their own words to a task of finding synonyms, thereby diverting attention from the real task or most relevant process.

A third possible reason for the non-significant difference between processing levels involves the treatment groups' differential familiarity with the processing methods. Some methods are already learned. It does not seem very reasonable that the Read and Copy group would do better than the Paraphrase group for this reason, however, since it would be expected that paraphrasing, just as much as copying, would have been overlearned long ago in these college undergraduate participants. It does seem more likely that differential familiarity with the methods might have been a significant factor in the comparison between the Read and Copy group and the Imagery group.

The two keyword mnemonic groups, of course, had the new and original mnemonic methods which were almost certain to have been unfamiliar to the great majority of participants. Thus, one might expect the differential familiarity with the methods to have been the most extreme in comparisons between the mnemonic groups and the Read and Copy group. This would have put the mnemonic methods at a considerable disadvantage. In retrospect, then, when considering the particular way in which the comparison between levels of processing was operationalized, it does not appear surprising that the groups composing the more elaborative processing levels, when considered together, performed about the same as the Read and Copy group.

Craik and Lockhart (1972) state that "...long term recall should be facilitated by manipulations which produce deeper or more elaborative processing" (p. 680). They make no differentiation among areas where this might occur. This research operationalizes "more elaborative processing" in terms of transformational processes (e.g., Take the information and paraphrase it or turn it into an appropriate mental picture). The assumption underlying the

appropriateness of these operationalizations is that if one does something with the information -- operates on it in some way other than originally processed -- then this is the more "elaborative" process. If the assumption is a valid one, long term retention of the information should be better than if the information is processed over and over in the same form that it is originally read, in definitional learning. Thus, other considerations being equal, any of these processes should produce superior long term retention of information: (a) correct responding to an application question; (b) correct responding to a comprehension question; (c) paraphrasing; (d) forming an image; (e) forming a verbal relationship with a keyword; (f) forming a pictorial interactive image using a keyword; (g) construction of inferences from the information provided; or (h) discovery of relationships of the new material with already acquired information. Thus, if rote linking can be equalized across the groups and degrees of familiarity with the processing methods can be more nearly equated in further research the assumption would imply that the more elaborative processing level would have superior long term retention.

The analysis of data from participants meeting the usage criterion accounts the degree of participants' adherence to the methods in the analysis in a way which the first analysis fails to do. That it is important to do so to make the most valid comparisons between treatment groups is indicated by two considerations: (a) the data from the within groups correlations and (b) participants' relative lack of skill and practice with the mnemonic techniques. First, the correlational data revealed a moderately strong relationship between the comprehension performance of the Imagery Keyword Mnemonic group and adherence to the imagery keyword mnemonic method ($r = .54$ overall). Second, reading and copying, paraphrasing and forming images are relatively highly practiced skills (i.e., familiar learning styles), while forming interactive images or verbal

relationships based on keyword mnemonics is not. Although most participants acquired the methods in the allotted time, the methods certainly were not overlearned. Some participants used the strange new mnemonic methods correctly on only a few items. The most valid comparisons between methods are between participants actually using the methods. Thus, if other factors are equal, the second analysis of data should be a better representation of differences between methods. However, the second analysis introduces the possibility that lower ability participants, who might have been less likely to have learned the new processing methods, may have been disproportionately deleted from the keyword groups. Although the design of the second analysis does not rule this out, it seems unlikely in view of the fact that an examination of participant responses revealed failures to use the mnemonic methods as stemming mainly from a misunderstanding of the linking techniques, (e.g., failing to include the keyword), rather than any intrinsically lower ability to use them.

In general, this study, consistent with the relational organization position of Bower (1970), extends the results of the research of Atkinson (1975), Atkinson and Raugh (1975), and Ott and associates (1973, 1976) in facilitating foreign language learning to the learning of definitions of unfamiliar English words. The greater effectiveness of the mediating techniques with concrete definitions confirms the viability of the dual processing orientation (Paivio, 1971) in the context of definitional learning. Furthermore, an encouraging feature, the methods for learning the concepts were acquired by most individuals in five minutes via a short instructional sequence. It appears that the methods can be used whenever unfamiliar concepts might be encountered and the defining terms understood. The Imagery Keyword Mnemonic technique, in particular, should be effective for general vocabulary building.

This technique also should be adaptable for use by texts or instructional sequences as an instructional aid. The development of a method for assessing degree of experimental control of information processing behaviors within the context of the definitional learning task is also viewed as a useful contribution to the research methodology. Finally, the research provides a detailed specification of a set of theoretically relevant variables for further exploration of facilitation of definitional learning through cognitive strategies.

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Table 1

Mean Ratings for 30 Definitions
Matched on Comprehensibility
and Complexity

LOW CONCRETENESS

Words	Prior Knowledge		Concreteness		Imagery		Comprehen-sibility		Complexity	
	M	SD	M	SD	M	SD	M	SD	M	SD
amerce	1.38	0.84	1.94	1.35	2.27	1.48	4.38	1.10	1.94	1.37
bewray	1.61	1.02	1.97	1.22	2.50	1.42	4.00	1.28	2.06	1.37
buncombe	1.25	0.69	2.50	1.48	2.56	1.42	4.21	0.85	2.74	1.11
exegesis	1.51	1.09	2.24	1.39	2.18	1.31	3.77	1.16	3.12	1.37
expiry	2.57	1.48	2.32	1.68	2.65	1.65	4.68	0.64	1.71	1.09
faugh	1.41	0.88	2.47	1.56	3.00	1.46	4.06	1.15	2.00	1.10
intercalate	1.38	0.79	2.41	1.31	2.59	1.35	4.18	0.94	2.09	1.31
nepenthe	1.20	0.60	2.50	1.40	2.21	1.37	3.97	1.17	2.41	1.33
nescience	1.40	0.85	1.77	1.28	2.27	1.48	4.21	1.23	1.82	1.19
nonage	1.60	1.02	2.24	1.33	2.41	1.44	3.77	1.37	3.15	1.56
objurgation	1.25	0.69	2.00	1.48	2.29	1.27	3.09	1.44	2.97	1.34
octroi	1.05	0.31	2.41	1.58	2.35	1.43	4.18	1.22	1.91	1.31
rennin	2.99	1.73	2.50	1.44	2.35	1.41	3.88	0.88	2.71	1.14
saprophytic	2.13	1.45	2.56	1.38	2.68	1.45	3.53	1.21	3.12	1.32
vituperation	1.37	0.85	2.59	1.48	3.00	1.60	3.77	1.30	2.53	1.19

Table 1 (con'd)

HIGH CONCRETENESS

Words	Prior Knowledge		Concreteness		Imagery		Comprehen-sibility		Complexity	
	M	SD	M	SD	M	SD	M	SD	M	SD
amice	1.65	1.19	4.38	1.05	4.35	1.18	4.41	1.10	2.15	1.35
carnelian	1.39	0.90	3.94	1.30	3.41	1.35	2.97	1.24	3.24	1.37
catafalque	1.49	1.05	4.32	1.04	3.85	1.44	4.00	1.33	3.21	1.53
chiton	1.72	1.15	4.27	1.05	4.38	0.78	4.44	0.82	2.44	1.26
curricle	1.33	0.84	4.44	0.99	4.21	1.12	4.47	0.99	2.09	1.19
faience	1.29	0.83	3.97	1.34	3.88	1.27	4.18	1.06	2.24	1.33
felly	1.22	0.63	4.12	1.27	3.97	1.19	4.41	0.99	1.79	1.27
hoyden	1.37	0.85	4.12	1.27	4.18	1.03	4.29	1.19	2.21	1.25
jodhpurs	2.24	1.57	4.38	1.10	4.27	1.31	4.29	1.22	2.15	1.16
mantelet	1.77	1.08	4.03	1.22	4.12	1.07	4.21	1.12	1.74	1.16
oryx	2.06	1.32	4.24	1.05	3.91	1.26	4.06	0.92	2.82	1.22
oxalis	1.41	0.93	3.97	1.14	3.65	1.20	3.77	1.37	2.65	1.39
posset	1.28	0.79	4.06	1.13	3.29	1.49	4.06	1.23	2.21	1.12
soutache	1.50	1.01	4.00	1.23	3.88	1.39	4.00	1.41	2.41	1.37
stolon	2.13	1.49	3.68	1.36	3.32	1.47	3.53	1.24	3.32	1.34

Table 2

Design

FACTORS

Processing Level	LEVEL 1 (Read & Copy)				(Read & write descriptions in terms of participants' own constructs)												BETWEEN - S
Processing Mode					VERBAL (Write in terms of own constructs)								IMAGE (Write description of mental pictures)				
Keyword Mediation					MEDIATION (Form relationship between mediating word and definition)				NO MEDIATION (Paraphrase)				MEDIATION (Interactive Imagery)				NO MEDIATION (Imagery)			
Concept Concreteness/ Abstractness	Abstract		Concrete		A		C		A		C		A		C		A		C	
Test Occasion (Immediate post or delayed post)	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2

WITHIN-S

Table 3

Means and Standard Deviations of the
Twelve Variables for the Experimental Groups
(N=120)

		Prior Knowledge			Adherence to Method			Comprehension[b]					
Group		APK[a]	CPK	TPK	AAM	CAM	TAM	ACOM1	CCOM1	TCOM1	ACOM2	CCOM2	TCOM2
Read and Copy	M	24.417	25.792	50.208	14.917	14.958	29.875	26.083	26.292	52.375	25.292	25.333	50.625
	SD	6.143	6.199	10.935	0.282	0.204	0.448	3.635	4.601	7.076	4.814	4.761	8.591
Verbal	M	23.833	23.208	47.042	14.083	13.750	27.833	21.458	20.167	41.625	21.542	20.000	41.542
	SD	6.638	7.541	13.186	1.998	2.707	4.498	6.757	5.836	11.454	6.731	6.379	12.097
Imagery	M	24.542	23.792	48.333	14.083	14.750	28.833	24.292	23.667	47.958	22.458	23.000	45.458
	SD	6.527	6.050	11.567	2.104	1.032	3.102	6.931	8.266	14.866	8.413	8.920	16.788
Verbal Keyword Mnemonic	M	22.333	20.250	42.583	10.792	11.792	22.583	24.500	25.667	50.167	23.417	24.958	48.375
	SD	5.585	5.152	8.747	4.054	3.413	6.934	5.831	5.546	10.921	6.567	5.886	11.974
Imagery Keyword Mnemonic	M	25.375	26.292	51.667	9.958	12.167	22.125	25.667	26.708	52.375	25.375	26.083	51.458
	SD	8.176	7.056	14.206	5.162	4.219	9.067	6.465	5.473	11.473	6.446	5.875	11.703

[a] APK - Abstract Prior Knowledge
CPK - Concrete Prior Knowledge
TPK - Total Prior Knowledge
AAM - Adherence to Method on Abstract Definitions
CAM - Adherence to Method on Concrete Definitions
TAM - Total Adherence to Method
ACOM1 - Immediate Abstract Comprehension
CCOM1 - Immediate Concrete Comprehension
TCOM1 - Immediate Total Comprehension
ACOM2 - Delayed Abstract Comprehension
CCOM2 - Delayed Concrete Comprehension
TCOM2 - Delayed Total Comprehension

[b] Abstract and Concrete Comprehension subscale means are underlined.

Table 4

Sources of Variance and Results of Tests from Mixed Model Repeated Measures ANOVA

Source of Variance	Hypothesis Mean Square	Error Mean Square	df	F-ratio	Level of Significance
Occasion	59.5021	10.522	1,115	5.655	.019*
Concreteness	3.8521	12.124	1,115	0.318	.574
Occasion X Concreteness	0.7521	4.922	1,115	0.153	.697
Level	327.5255	133.027	1,115	2.462	.119
Occasion X Level	0.8755	10.522	1,115	0.083	.774
Concreteness X Level	0.0880	12.124	1,115	0.007	.932
Occasion X Concreteness X Level	0.7922	4.922	1,115	0.161	.689
Mode within Level 2	362.3151	133.027	1,115	2.724	.102
Mode within Level 2 X Occasion	3.5651	10.522	1,115	0.339	.562
Mode within Level 2 X Concreteness	4.8151	12.124	1,115	0.397	.530
Mode within Level 2 x Occasion X Concreteness	0.7526	4.922	1,115	0.153	.697
Mediation within Level 2	997.8151	133.027	1,115	7.501	.007**
Mediation within Level 2 X Occasion	0.0234	10.522	1,115	0.002	.963
Mediation within Level 2 X Concreteness	81.5859	12.124	1,115	6.729	.011*
Mediation within Level 2 X Occasion X Concreteness	1.1484	4.922	1,115	0.233	.630

*p < .05
**p < .01

(Continued on next page)

Table 4 (con'd)

Source of Variance	Hypothesis Mean Square	Error Mean Square	df	F-ratio	Level of Significance
Mediation within Level 2 X Mode within Level 2	36.8776	133.027	1,115	0.277	.600
Mediation within Level 2 X Mode within Level 2 X Occasion	16.2526	10.522	1,115	1.545	.217
Mediation within Level 2 X Mode within Level 2 X Concreteness	20.6276	12.124	1,115	1.701	.195
Mediation within Level 2 X Mode within Level 2 X Occasion X Concreteness	6.7734	4.922	1,115	1.376	.243

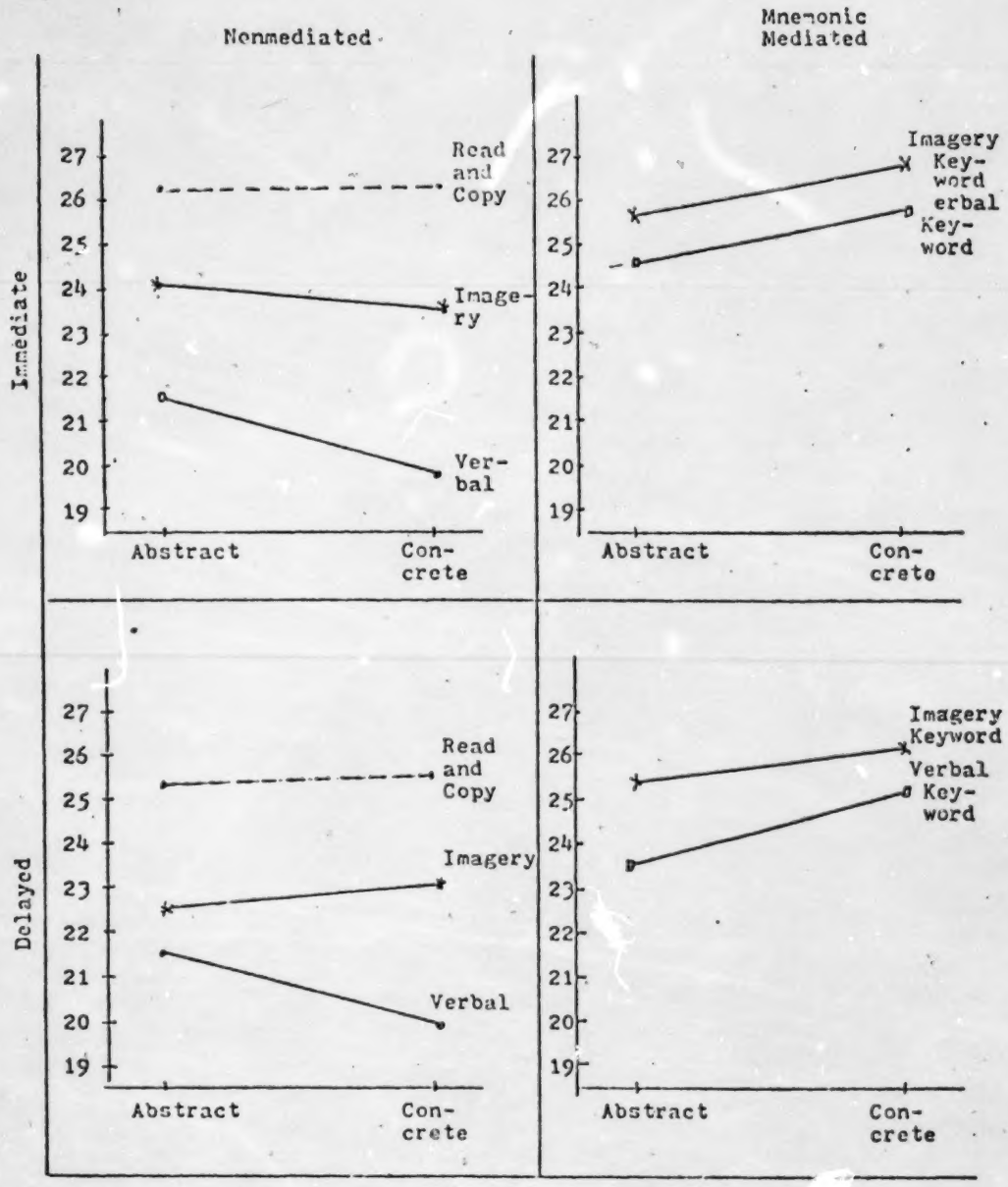

Figure 1

Graphs of Mean Comprehension Scores from Analysis of All Participants (N=120).

Table 5

Means and Standard Deviations
(Participants who used correct method
at least half of the time, N=95.)

Group Labels	Immediate Abstract Comprehension		Immediate Concrete Comprehension		Delayed Abstract Comprehension		Delayed Concrete Comprehension	
	M	SD	M	SD	M	SD	M	SD
Read and Copy	25.684	3.772	26.158	4.717	24.263	4.897	24.316	4.843
Paraphrase	21.421	7.206	20.737	5.332	21.421	6.899	20.105	6.514
Imagery	23.474	7.530	22.632	8.688	21.737	9.042	22.105	9.480
Verbal Keyword Mnemonic	24.211	5.968	26.421	4.501	23.263	6.789	25.421	5.610
Imagery Keyword Mnemonic	27.526	3.864	28.421	2.631	26.842	4.610	28.053	4.020

Table 6

Sources of Variance and Results of Tests from Mixed Model Repeated Measures ANOVA on Participants Using Correct Method at Least Half of the Time.

Source of Variance	Hypothesis Mean Square	Error Mean Square	df	F-ratio	Level of Significance
Occasion	79.6737	10.732	1,90	7.424	.008**
Concreteness	19.4632	12.999	1,90	1.497	.224
Occasion X Concreteness	0.1684	4.354	1,90	0.039	.845
Level	76.0526	122.079	1,90	0.623	.432
Occasion X Level	12.1684	10.732	1,90	1.134	.290
Concreteness X Level	0.8526	12.999	1,90	0.066	.799
Occasion X Concreteness X Level	1.5158	4.354	1,90	0.348	.557
Mode within Level 2	375.8026	122.079	1,90	3.078	.083
Mode within Level 2 X Occasion	0.6447	10.732	1,90	0.060	.807
Mode within Level 2 X Concreteness	0.6447	12.999	1,90	0.050	.824
Mode within Level 2 X Occasion X Concreteness	5.8026	4.354	1,90	1.333	.251
Mediation within Level 2	1584.3289	122.079	1,90	12.978	.001**
Mediation within Level 2 X Occasion	0.0132	10.732	1,90	0.001	.972
Mediation within Level 2 X Concreteness	95.0658	12.999	1,90	7.313	.008**
Mediation within Level 2 X Occasion X Concreteness	0.1184	4.354	1,90	0.027	.869

*p < .01

(Continued on next page)

Table 6 (con'd)

Source of Variance	Hypothesis Mean Square	Error Mean Square	df	F-ratio	Level of Significance
Mediation within Level 2 X Mode within Level 2	32.8947	122.079	1,90	0.270	.605
Mediation within Level 2 X Mode within Level 2 X Occasion	7.5789	10.732	1,90	0.706	.403
Mediation within Level 2 X Mode within Level 2 X Concreteness	17.0526	12.999	1,90	1.312	.255
Mediation within Level 2 X Mode within Level 2 X Occasion X Concreteness	2.5789	4.354	1,90	0.592	.444

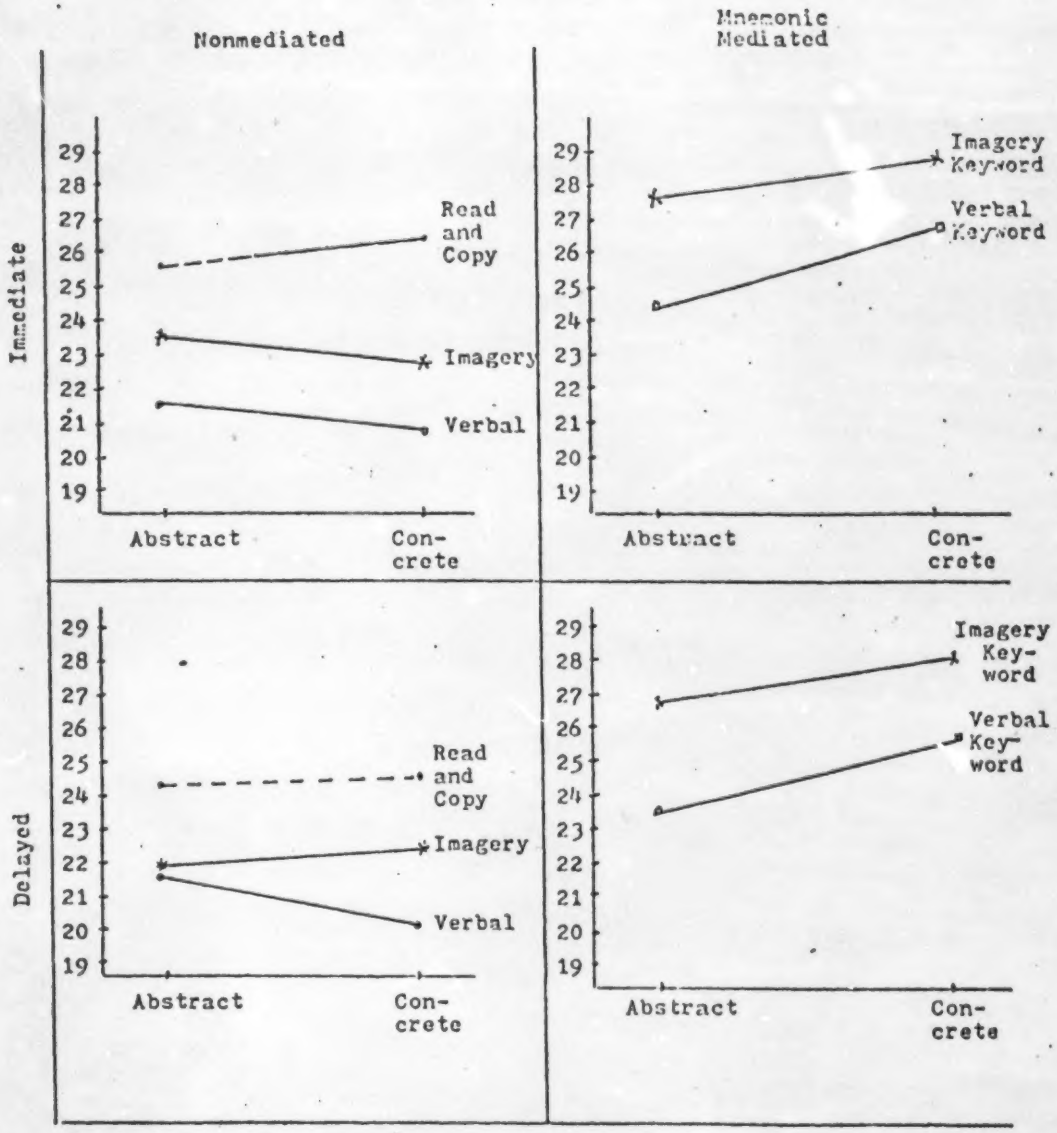

Figure 2

Graphs of Mean Comprehension Scores from Analysis of Participants Who Used Correct Method at Least Half of the Time (N=95).

Footnotes

Copies of the instructional sets and other experimental materials may be obtained from the author at the Department of Educational Administration and Foundations, Kansas State University, Manhattan, Kansas 66506.